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METHODS OF MEASURING COTTON FIBER ORIENTATION AND HOOKS AND THEIR EFFECTS ON PROCESSING PERFORMANCE 1945-69

AN ANNOTATED BIBLIOGRAPHY

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METHODS OF MEASURING COTTON FIBER ORIENTATION AND HOOKS AND THEIR EFFECTS ON PROCESSING PERFORMANCE 1945-69: AN ANNOTATED BIBLIOGRAPHY

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INTRODUCTION

Since the introduction of the spinning jenny at the beginning of the industrial revolution, it has been well known that to spin a smooth, strong textile yarn the fibers must be parallel. This was the primary reason that drawing was introduced to precede spinning. However, for many years, even in some of the most modern mills, there was no quantitative assessment of fiber parallelization because of lack of rapid methods of measurement. This failure to develop and apply methods of measuring fiber parallelization has hindered progress in developing improved textile processing machinery and processing organizations.

In recent years there has been a great deal of effort in developing methods of measuring fiber orientation and in determining the effect of processing parameters on fiber hooks and parallelization and on processing performance. This effort has been expended by many researchers in many countries.

The purpose of this annotated bibliography is to bring together for ready reference the many publications which have appeared, as an aid for continuing research efforts in this field. No doubt some publications, more likely foreign ones, have been missed. It is hoped that the authors will treat these errors of omission sympathetically, realizing the difficulty in locating all papers.

Foster and coworkers (1) in 1945 were probably the first to develop a method for measuring fiber parallelization when they showed that the "projected mean length" of the fibers of a sliver or roving could be obtained by a rapid clamping procedure.

Martindale (2) in 1947 showed that card sliver fibers were preferentially hooked in the trailing direction, when he found that the drafting force of card sliver was greater when drafted in the normal (same direction as coming off the card) than the reverse direction.

In 1949 Morton and Summers (3) determined the various types and amounts of fiber hooks in card sliver with the use of a tracer fiber technique.

Since these early developments, techniques for measuring fiber parallelization and fiber hooks and studies of their effects on processing have accelerated. Lindsley (5) in 1951 used a method somewhat similar to that of Foster to determine fiber parallelization. Simpson (16) in 1961 showed that the "cutting ratio" of this method could effectively be used in determining fiber hooks and Leont'eva (31) in 1964 showed that an index from this method termed the "coefficient of relative parallelization" could be used as a measure of the overall fiber parallelization. Using a method similar in principle to that of Foster, Pittman and Tallant (58) in 1969 developed a simple technique for measuring fiber "projected mean length."

This annotated bibliography contains most of the articles published since 1945 on methods of measuring fiber parallelization and hooks and their effects on processing performance. An abstract of each article is given. For the sake of uniformity in the abstracts, the trailing fiber hooks of the card web are termed the "majority hooks" and the leading ones the "minority hooks."

The bibliography is arranged chronologically by years and alphabetically by authors within years. An author index appears at the end.

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[1] Southern Regional Research Laboratory is one of the facilities of the Southern Utilization and Development Division, Agricultural Research Service, U. S. Department of Agriculture, New Orleans, La.

[2] Bold numbers in parentheses refer to Bibliography listed.

Availability of References Cited

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Textile Machinery Society of Japan,
Volumes 1 to 14, incl., 1955-68
Textil Praxis,
Volumes 5 to 23, incl., 1950-68
Textile Research Journal,
Volumes 3 to 38, incl., 1932-68
Textile Technology Digest,
Volumes 1 to 25, incl., 1944-68
Textile World,
Volumes 84 to 116, incl., 1934-68
Zeitschrift fur Die Gesamte Textil Industrie,
Volumes 56-70, incl., 1954-68

(1) FOSTER, G. A. R., GREGORY, J., and WOMERSLEY, J. R. – SOME CALCULATIONS RELATING TO THE ARRANGEMENT OF FIBERS IN SLIVERS AND ROVINGS. Jour. Textile Inst. 36: T311-323. 1945.

A sliver clamping and combing technique was used to measure the parallelization of the fibers. The theory for the technique is based on the number of right-hand ends of fibers in a particular length of sliver. A method for obtaining the projected mean length was devised. The sliver is clamped under a bar one-half inch in length and is combed on both sides, and the clamped portions are cut at the edge of the bar and weighed. The sliver under the bar is also weighed to obtain the mass per unit length of the sliver.

L_1 (projected length) = $\frac{M_1}{M}$

M_1 = Weight of the clamped, combed fiber beards

M = Weight per unit length of sliver under clamping bar

The mean length of the thick places in the roving was slightly shorter than the mean length of the thin places, because during drafting the thick places tend to carry the floating fibers which are the shorter ones.

(2) MARTINDALE, J. G. – AN INSTRUMENT FOR THE MEASURMENT OF THE FORCES OPERATING BETWEEN FIBERS DURING DRAFTING. Jour. Textile Inst. 38: T151-166. 1947.

An instrument that measures the drafting force of sliver was developed. This instrument measures the deflection of the suspended front drafting rolls which is proportional to the drafting force. The drafting force of the sliver with the majority hooks trailing was greater than with them leading at several different roll settings.

(3) MORTON, W. E., and SUMMERS, R. J. – FIBRE ARRANGEMENT IN CARD SLIVERS. Jour. Textile Inst. 40: P106-116. 1949.

Viscose staple 1-7/16 in., 1.5 den. was processed into a 12 oz./yd. lap to which 0.02 percent black dyed tracer fibers of the same material was added. Sliver weighing 40 gr./yd. was carded at a doffer R.P.M. of 8. Sliver was submerged in methyl salicylate and tracer fibers viewed with a six-power microscope. Approximately 48 percent of the fibers had trailing ends hooked, 16 percent had leading ends hooked, 13 percent had both ends hooked and 21 percent had no ends hooked. The trailing hooks were larger than the leading ones.

(4) MORTON, W. E., and SUMMERS, R. J. – FIBRE ARRANGEMENT IN FIBRE DRAW FRAME SLIVERS. Jour. Textile Inst. 41, T349-360. 1950.

By using a 40 gr./yd. card sliver of 1.5 den. 1-7/16 in. viscose with 0.02 percent tracer fibers, the authors studied the effect of drawing on hook removal. Leading hooks were more readily removed by drafting than trailing hooks. The longer fibers tended to straighten better than the shorter ones.

(5) LINDSLEY, C. H. – MEASUREMENT OF FIBER ORIENTATION. Textile Res. Jour. 21: 39-46. 1951.

A description of a mechanical technique and instrument for measuring fiber orientation is given. A lap, sliver, or roving is clamped under two metal plates. The material is cut at the edge of one plate and this plate is removed, the material still being clamped under the other plate. This exposed portion is combed and the fibers being combed out are labeled C. The part is reclamped over the combed portion and the fibers now extending beyond this plate are cut and labeled E. The plate is again removed and the fibers are cut at the edge of the inner gripping plate and labeled N. The orientation measurements are defined as the combing ratio E+N which is claimed to be an index of the randomness of orientation, and the orientation index $\frac{C}{E+N}$ (100) which indicates the parallelization of the fibers. The optimum plate width for cottons appeared to be one-half inch.

(6) MORTON, W. E., and YEN, F. C. – FIBRE ARRANGEMENT IN COTTON SLIVERS AND LAPS. Jour. Textile Inst. 43: T463-472. 1952.

Using a long-staple Egyptian Karnak cotton with 0.10 percent of black dyed tracer fibers added to the picker lap, the authors studied fiber hooks at the card, first, second, and third drawing, sliver lapper, ribbon lapper, and comber. The proportion of hooks in the cotton card sliver were about the same as those in the viscose slivers previously studied. First drawing removed the largest percentage of hooks. Approximately 60 percent of fiber hooks were removed by three drawing processes and approximately 85 percent were removed through combing. there was also some indication that there was a slight increase in leading hooks as the comber sliver was processed through three drawings.

(7) MORTON, W. E., and Nield, R. – THE EFFECT OF LAP PREPARATION ON WASTE EXTRACTION AT THE COTTON COMBER. Jour. Textile Inst. 44: T317-334. 1953.

The effect of comber lap preparation on fiber hooks and noil removal was studied. Two long-staple

Sudan Sakel cottons of 1-7/16 and 1-11/16 in. staple lengths were used. One-tenth percent of dyed tracer fibers were placed into the picker laps of the 1-7/16 in. cotton. The drafting direction of the majority hooks was varied at first drawing, sliver lapper, ribbon lapper, and comber. The results showed that the majority hooks should lead into the comber for minimum noil removal.

(8) ORCHARD G. A. J. –THE MEASUREMENT OF FIBRE ORIENTATION IN CARD WEBS. Jour. Textile Inst. 44: T380-385. 1953.

A method was developed to measure the orientation of fibers in a web by measuring the total intensity of light scattered normal to the web. The apparatus makes use of two prisms to direct the beams of light upon the web and a photocell to measure the intensity of the reflected light. The orientation coefficient is given by (maximum photocell output/minimum photocell out) -1. The coefficient is zero for a perfectly random distribution.

(9) ITANI, W. – FIBER ORIENTATION. Jour. Textile Mach. Soc. Japan, 5(1): 10-24. 1959.

Theoretical formulae were derived which enable the calculation of the orientation angle of a fiber assembly when the fiber tuft diagram (obtained with the Fibrograph) and the cutting and combing ratios obtained by the Lindsley method are measured.

(10) NUTTER, W., and Slater, W. – A CRITICAL ASSESSMENT OF RECENT PROGRESS IN THE TECHNOLOGY SPINNING. Jour. Textile Inst. 40: P397-428. 1959.

Machinery developments are described which in the postwar years have led to higher drafts, larger packages, and higher machine speeds. The importance of fiber arrangement and sliver regularity is examined, and the effect on processing in carded and combed yarn and in sliver-to-yarn spinning is discussed. The direction of the majority hook at spinning greatly affected yarn strength in both the conventional and direct sliver spinning systems. The effect became greater as the number of prespinning processes were reduced.

(11) TABATA, M., HAYAKAWA, K., and TAKIZAWA, T. – THE SHAPE AND PARALLELIZATION OF FIBERS IN SLIVERS AND THEIR DIRECTIONAL PROPERTIES. Jour. Textile Mach. Soc. Japan, 6(1): 5-10. 1960.

Using a 30/1 (20 tex) yarn cut into staple as tracers, the authors evaluated the Lindsley method for measuring fiber parallelization and hooks. It was found that the orientation index of the Lindsley method should be computed in both directions for slivers. The log of the percentage of hooks was linearly related to the number of processes. This was expeted from the theoretical considerations.

(12) ZHOKHOVSKII, V. V. – AN INSTRUMENT FOR DETERMINING FIBRE STRAIGHTNESS IN SLIVER AND ROVING. Technol. Textile Indus. U.S.S.R. 2: 49-53. 1960.

A method for determining fiber parallelization was developed on the principle that for sliver gripped within the longest fiber length the elongation under load will be inversely related to parallelization. An instrument was developed to measure the elongation under load.

(13) GARDE, A. R., WAKANAR, V. A., AND BHADURI, S. N. – FIBER CONFIGURATION IN SLIVER AND ROVING AND ITS EFFECT ON YARN QUALITY. Textile Res. Jour. 31: 1026-1036. 1961.

Using flourescent tracer fibers and the combing ratio of the Lindsley technique, the authors showed that both majority and minority hooks were more readily removed when trailing into drafting than when leading. For better yarn strength and uniformity, the majority hooks should trail into spinning. When the majority hooks differed and led into the spinning frame, there was a significant difference in yarn strength and uniformity; in contrast, when the minority hooks differed and led into spinning no differences in yarn strength and uniformity were evident.

(14) LYSENKO, L. YA., AND KREITSBERG, Z. N. – DETERMINATION OF STRAIGHTNESS AND PARALLELIZATION OF FINE-WOOL FIBRE BY MEANS OF RADIOACTIVE ISOTOPES. Technol. Textile Indus. U.S.S.R. 6: 63-68. 1961.

Wool fibers were made radioactive by immersing them in radioactive phosphoric acid. The fibers were individually placed along the length of woolen card sliver. The sliver was processed tough a number of drawings (gillings) and combing with the variables being draft, number of doublings, and process. The slivers were exposed to X-ray film and autoradiographs made. The parallelization of the fibers were measured. The straightening efficiency for the first gilling was 62 percent, the second, 14.3 percent, and the third, 2.24 percent. Increasing the doublings from 4 to 8 increased the general coefficient of fiber straightness from 67.5 to 70.5

(15) MERCHANT, V. B. – THEORETICAL ASPECTS OF HOOK REMOVAL AT DRAFTING OPERATIONS. Textile Res. Jour. 31: 925-931. 1961.

Using a relatively simple model, the author devised theoretical equations for eliminating trailing and leading hooks during drafting. These equations show that trailing hooks are more easily removed by drafting than leading hooks.

(16) SIMPSON, J. – SLIVER DIRECTION, HOOKED ENDS HAVE SIGNIFICANT EFFECT ON THE PARALLELIZATION OF COTTON FIBERS. Textile Bull. 87(7): 39-42. 1961.

Using short-, medium-, and long-staple cottons and comparing the results obtained on fiber hooks with tracer fibers with the cutting ratio (E/N) of the modified Lindsley method, the author showed that this mechanical method could be used as a measure of fiber hooks. Fiber hooks were better removed by drafting when they were in the trailing direction. The longer fibers of a particular cotton had more hooks than the shorter ones in card sliver but drafting straightened the longer ones better than the shorter ones.

(17) WAKANKAR, V. A., BHADURI, S. H., RAMASWAMY, B. R., AND GHOSH, G. C. – SOME STUDIES ON THE FORMATION OF HOOKS IN CARDING. Textile Res. Jour. 31: 931-940. 1961.

With the use of flourescent dyed tracer fibers and the combing ratio of the Lindsley technique, the effect of several carding parameters on fiber hook formation was studied.

With the tracer fibers, it was found that increasing carding rate by increasing the doffer speed decreased the majority (trailing) and increased the minority (leading) fiber hooks of card sliver.

The lickerin, flats and doffer comb had an insignificant effect on the formation of fiber hooks.

At the same production rate changing the ratio between the cylinder and doffer had no effect on hook formation.

(18) FUJINO, K., AND ITANI, W. – EFFECTS OF CARDING ON FIBER ORIENTATION. J. Textile Machinery Soc. Japan 8(4): 1-8. 1962.

The fiber orientation at various places on the card was studied with the use of a microscope (X20 or 50) having a field of vision of 2 or 6 mm. and equipped with an Abbe descriptive apparatus. The orientation of fibers in the lap and web were about equal and very poor. The fiber orientation on the cylinder was very good but deteriorated on the doffer.

Increasing the doffer speed increased the neps in the card web but improved fiber orientation.

(19) GHOSH, G. C., AND BHADURI, S. N. – DEPENDENCE OF HOOK REMOVAL AT DRAWING ON SOME DRAFTING PARAMETERS. Textile Res. Jour. 32: 864-866. 1962.

Widening the roll settings at drawing by three-sixteenth of an inch did not affect fiber hook removal when using a low draft (2.1). Fiber hooks were removed better in a light than heavyweight sliver. An increase in draft decreased the trailing hooks but did not affect the leading hooks.

(20) MERCHANT, V. B. – THEORETICAL ASPECTS OF HOOK REMOVAL AT DRAFTING OPERATIONS: PART II: THE INFLUENCE OF CHANGES IN DRAFT DISTRIBUTION ON THE REMOVAL OF TRAILING AND LEADING HOOKS. Textile Res. Jour. 32: 805-810. 1962.

The factors favorable to trailing and leading hook removal were theoretically derived.

The formula derived for the total length in the drafting zone favorable to trailing hook removal is $\frac{DS}{r+D}$ where D = total draft, S = roll setting, and r = critical surface contact ratio. For leading hook removal, it is $\frac{rDS}{1+Dr}$. The reduction in trailing hook extent is $\frac{S(D-1)}{2(r+D)}$ and the leading hook extent is $\frac{S(D-1)}{2(1+Dr)}$. These formulae show that at any draft the decrease in the hook extent of the trailing hooks increases rapidly but that of leading hooks increases only slowly. Hence, the disparity between the removal of trailing and leading hooks increases rapidly with increase in draft. When a given total draft is concentrated in fewer zones, the extent of removal of trailing hook increases whereas that of leading hooks slowly decreases.

(21) RAES, I. G. – VEZELSCHIKKING EN HARR GEVOLGEN OF WEERSTAND EN REGELMATIGHEID VAN KATOENGAREN. Textilis 18(2): 15-18 (In Flemish). 1962.

The tracer fiber technique was used in this study. Both majority and minority hooks were removed better when they were drafted in the trailing direction. The best sliver direction at drawing was to have the majority hooks trailing at first drawing, leading at second. This produced slightly better parallelization than when the majority hooks trailed at both first and second drawing. When the majority hooks trailed into spinning, the yarn was stronger than when they led. The difference became larger as the yarn became finer. Increasing carding rate decreased the majority and increased the minority hooks.

(22) RAO, J. S., AND GARDE, A. R. – THEORETICAL COMPUTATIONS OF COMBING RATIOS OF IDEALS AND QUASI-IDEAL SLIVERS. Jour. Textile Inst. 53: T430-445. 1962.

With the assumption that the fibers are in a random distribution, a theoretical expression was derived for the combing ratio. A formula was also derived for the combing ratio of fibers with hooks. To calculate the combing ratios from these formulae, the fiber length distribution and mean hook extent must be known. The index of fiber configuration is given as:

$C = \frac{2(1+R_1)}{R_f+R_b+2}$

R_1 = Ideal combing ratio which must be computed

R_f = Forward combing ratio

F_b = Backward combing ratio

Index of differential hooking is:

$I = \frac{2(R_f-R_b)x100}{R_f+R_b+2}$

(23) SIMPSON, J. – COMPARISON OF THE COMBING AND CUTTING RATIOS AS AN INDICATION OF FIBER ARRANGEMENT. Textile Res. Jour. 32: 614-615. 1962.

Tracer fibers and the cutting and combing ratios of the modified Lindsley technique were used. The percent decrease in cutting ratio corresponded much better with the percent decrease in fiber hooks (tracer fibers) than did the percent decrease in combing ratio when the sliver samples were drafted. The combing ratios in the forward and reverse direction did not correspond with the majority and minority hooks in many instances. This never occured when the cutting ratio was used.

(24) VALOTA, A. – FORMATION OF HOOKS IN CARD WEB AND THEIR ELIMINATION IN THE SUCCESSIVE PASSAGES. Industrie Textile 902: 369-373. (In French) 1962.

Tracer fiber and the combing ratios of the Lindsley test were used. Increasing card production decreased the majority and increased the minority hooks. Both the combing ratio in the forward direction and in the reverse direction increased with production and the difference between the two became less. Both the majority and the minority hooks were removed better when trailing into the drafting process. A favorable passage through drawing was defined as one where the majority hooks trailed. Yarn strength was greater and the irregularity lower when the majority hooks trailed into spinning. Yarn strength increased and irregularity decreased as the number of favorable (majority hooks trail) passes increased at the prespinning drafting processes.

(25) WAKANKAR, V.A., AND BHADURI, S. N. ,– THE EFFECT OF FIBER CONFIGURATION IN FEED ON COMBER WASTE. Textile Res. Jour. 32: 641-652. 1962.

Using short (Indian), medium (American) and long (Egyptian) staple cottons, the authors studied the effect of the amount of hooks and direction of feed on comber waste. The majority hooks should lead into the comber. The percentage difference in comber noils when the majority hooks led and trailed became greater as the fibers became more parallel. The difference was also greater at wider step guage settings.

When the top comb was removed, it was found that the opposite was true. That is, more noils were removed when the majority hooks led into the comber. This was believed to be due to the fact that the lap was opened better, permitting the cylinder to penetrate farther.

(26) ANONYMOUS. – PARALLEX TEST APPARATUS. Melliand Textilberichte (English Edition) 3:146. 1963.

Described is an apparatus that determines the parallelization of sliver and rovings in terms of the "useful" or projected mean length. The sliver is cut into 10 equal test lengths by the apparatus. All of the test lengths are clamped in the center and the fibers on both sides are combed, by turning a handwheel.

The combed out portion and the clamp portions are suspended on the two arms of the parallex scales and a pointer indicates the average "useful" or projected mean length.

(27) SIMPSON, J., DELUCA, L. B., AND FIORI, L. A. – THE EFFECT OF HOOKED FIBER ENDS ON PROCESSING. Textile Bul. 89(5): 52-57. 1963.

The applicability of using the cutting ratio (E/N) of the modified Lindsley method to measure the effect of processing on fiber hooks and vice versa is demonstrated. So that the trailing and leading fiber hooks of the card web can easily be followed through the processing steps, the trailing hooks are defined as the "majority" and the leading ones as the "minority."

Drafting removed hooks better when they were trailing than when leading. However, at very low drafts there were some indications that the leading hooks were removed better than the trailing ones. When the "majority" hooks were drafted in the trailing direction the uniformity of sliver and roving was improved over that when they were leading. Fiber hooks had a greater effect on spinning end breakage than on yarn strength.

(28) WEBENER, W., AND PEUKER, H. THE SLIVER SPINNING PLANT, PART IV THE INFLUENCE OF ONE, TWO, AND THREE DRAWING PROCESSES ON THE YARN AND WOVEN PRO-

DUCTS. Zeitschrift fur Die Gesamte Textil Industrie 65(8):592-602. (In German). 1963.

This is a comprehensive review of the methods of measuring fiber parallelization and fiber hooks. Included are the parallex method, the tracer fiber technique, and the Lindsley method. The difference methods of measuring fiber parallelization are compared for various processes.

(29) WEGENER, W., AND PEUKER, H., – THE SLIVER SPINNING PLANT, PART IV. THE INFLUENCE OF ONE, TWO AND THREE DRAWING PROCESSES ON THE YARN AND WOVEN PRODUCTS. Zeitschrift fur Die Gesamte Textil Industrie 65(9): 690-700. (In German) 1963.

A review of the literature on fiber hooks is presented with the objective of developing new findings by combining the results from several authors. It is shown that when carding rate is increased the majority hooks decrease and the minority hooks increase. Increasing the fiber length increases the majority hooks.

(30) KLEIN, W. G. – ON THE MECHANICS OF ROLLER DRAFTING. Progress Report No. 4 on the Mechanics of Deformation in Cotton Fabrics, Fibers and Polymers Division, Mass. Inst. Technol. 1964.

Leading hook removal reached a maximum at very low drafts. Trailing hook removal increased with increasing draft without going through a maximum. Increasing roll setting facilitated removal of trailing hooks. Short-hooked lengths of fiber were more easily removed than long ones. Long-hooked fibers were easier to straighten than short fibers, particularly for trailing hooks.

(31) LEONT'EVA, I. S. – PROBLEM OF FIBER STRAIGHTENING DURING SLIVER PREPARATION. Technol. Textile Indus. U.S.S.R. 2: 57 – 63. 1964.

The modified Lindsley method was used to measure fiber hooks and fiber parallelization. The proportion of hooked fibers obtained with the tracer fiber technique was said to be best described by $P = \frac{E}{E+N}$ (100), termed the hooked fiber index.

The coefficient of relative fiber parallelization was defined as $K_{r.p.} = (1 - \frac{C}{C+N+E})$ 100, which is the percentage of clamped fiber weight in the Lindsley test.

Fiber hook removal was studied for three passages of drawing. Five different draft directions were employed. P was inversely related to the number of times the majority hooks trailed. However, there was no relation between $K_{r.p.}$ and the number of times the majority hooks trailed, indicating that P is a more sensitive measure of fiber hooks than $K_{r.p.}$ Sliver uniformity and single strand breaking strength uniformity increased with the number of favorable drawing passages (majority hooks trailing).

(32) SIMPSON, J., DELUCA, L. B., FIORI, L. A., AND LOUIS, G. L. – FIBER HOOKS: THEIR EFFECT ON YARN PROPERTIES AND END BREAKAGE IN SPINNING. Textile Indus. 128(3): 78 – 83, 85 – 86. 1964.

Drafting direction had a significant effect on fiber hook removal; the majority and minority hooks were more easily removed when drafted in the trailing position.

With drafting directions that included both majority and minority hooks entering spinning, end breakage was directly and yarn strength inversely related to the cutting ratio entering spinning. The majority hooks should always trail into spinning. Fiber hooks affected end breakage more than yarn strength, and had a more critical effect when processing steps were eliminated. The optimum drafting direction was to have the majority hooks trailing at both first and second drawing, leading at roving and trailing into spinning.

(33) ZADERII, G. N. – THE STRUCTURE OF CONDENSER ROVING. Technol. Textile Indus. U.S.S.R. 4: 44 – 46. 1964.

The fiber arrangement of condenser roving from the woolen card was studied by the tracer fiber technique. Of the fibers, 46 percent had their trailing ends hooked, 16 percent, their leading ends hooked, 18 percent, both ends hooked, and 12 percent, without hooks. This is similar to the hooking pattern for the cotton card sliver. The extent of the leading hook was greater than that of the trailing hook.

(34) ZADERII, G. N. – THE EFFECT OF THE MAGNITUDE AND DIRECTION OF DRAFTING ON FIBER STRAIGHTENING IN CONDENSER ROVING. Technol. Textile Indus., U.S.S.R. 5: 46 – 49., 1964.

With tracer fibers added at the woolen, condenser card, the effect of draft and draft direction on fiber hooks in condenser roving and yarn was studied. Draft straightened the trailing hooks but had little effect on the leading hooks. Yarn irregularity increased when the majority hooks were drafted in the trailing direction.

(35) BARELLA, A., AND SUST, A. – THE RELATIONSHIP BETWEEN MINIMUM TWIST OF COHESION AND "CUTTING RATIO" IN COTTON ROVINGS. Textile Res. Jour. 35: 285 – 288. 1965.

The cutting ratio was directly related to the minimum twist of cohesion. This indicates that the minimum twist of cohesion could be used as a measure of fiber parallelization for studying the effect of processing variables on a particular cotton.

(36) DELUCA, L. B. – AN EVALUATION OF HOOKED FIBERS IN COTTON SLIVER ON A RELATIVE BASIS. Textile Res. Jour. 35: 858 – 861. 1965.

It was shown that $\frac{E}{C+E+N}(100)$ of the modified Lindsley technique, termed percent E, correlated somewhat better with the tracer fibers of that study than did the cutting, but much better than the combing ratio.

(37) GHOSH, G. C., AND BHADURI, S. N. – FIBER LAYERS ON CYLINDER AND FLATS IN A REVOLVING FLAT CARD AND THEIR INFLUENCE ON CARDING QUALITY. Seventh Technol. Conf., Ahmedabad Textile Indus. Res. Assoc. Sess. 4, pp. 130 – 136. 1965.

Increasing the cylinder speed decreased cylinder load, increased the majority, and decreased the minority hooks. There was also a slight decrease in yarn imperfections. There was little difference in the fiber hook percentages when the lap weight was changed from 12 to 17 ounces a yard. Decreasing the sliver weight at a constant cylinder-to-doffer speed ratio and constant production decreased the cylinder load, decreased the majority, and increased the minority hooks. The lighter weight sliver processed into a stronger more uniform yarn.

(38) OWALEKAR, R. G. – COMBING RATIOS AS MEASURE OF FIBER HOOKING. Jour. Textile Inst. 56: T696 – 698. 1965.

With three assumptions, the theoretical formulae of Rao for expressing the ideal combing ratio, the extent of relative differential fiber hooking and the index of fiber configuration were simplified. In some instances the combing ratio forward was not larger than the combing ratio backward, even though there were more trailing than leading hooks. Both the index of fiber configuration and the index of relative differential fiber hooking are dependent on fiber length.

(39) PARTHASARATHY, M. S. – COMPARISON OF LAP PREPARATION FOR COMBER. Sixth Technol. Conf., January. Sess. 2, pp. 40 – 48. The Bombay Textile Res. Assoc. 1965.

The effects of seven different methods of lap preparation on fiber hooks and waste removal at the comber were investigated using the cutting ratio. There was a direct relation between the average cutting ratio of the lap entering combing and the waste removal. The lap preparation that resulted in the lowest cutting ratio resulted in the lowest waste removal. This was three drawing processes, sliver lap, and comber.

The cutting ratio value for the comber slivers was negligibly small, indicating the presence of very few hooks. Despite the difference in comber waste removal, the yarn strength and uniformity of all lots were approximately the same.

(40) RAMASWAMY, B. R., GHOSH, G. C., AND SARMA, R. S. – HIGH PRODUCTION CARDING. Seventh Technol. Conf. Ahmedabad Textile Indus. Res. Assoc., pp. 137 – 148. 1965.

The effect of increasing card production on fiber hooks and yarn quality was studied for a conventional, semihigh production and high production card. There was no significant difference in the cutting ratio with increase in card production.

There was no change in yarn strength with increased card production. The yarn grade decreased, and the imperfections per 100 meters increased with increased production. This increase in yarn imperfections with increasing carding rate was not as marked in combed yarns. In mill tests there was a decrease in end breakage with increased card production in many instances.

(41) SIMPSON, J., AND DELUCA, L. B. – EFFECT OF SLIVER WEIGHT ENTERING DRAWING ON FIBER HOOK REMOVAL. Textile Res. Jour. 35: 675 – 676. 1965.

Both the majority and minority hook removal decreased as weight sliver increased, and increased as the draft increased. Since it is known that a lightweight sliver drafts into a more uniform roving than a heavyweight it was concluded that at constant draft, drafting uniformity and hook removal were directly related.

(42) SIMPSON, J., DELUCA, L. B., AND FIORI, L. A. – FIBER HOOKS: EFFECT ON YARN PROPERTIES AND END BREAKAGE IN SPINNING FOR A SHORT STAPLE COTTON. Textile Indus. 129(5): 110 – 111, 113, 117. 1965.

The effect of drafting direction on the removal of fiber hooks during processing and the effect of hooks on yarn properties and end breakage were investigated for a fifteenth/sixteenth of an inch middling cotton. The amount of fiber hooks entering spinning had a more critical effect on end breakage as the yarn became finer, with the amount of hooks leading being more critical than those trailing. The improvement in end breakage between the conven-

tional and the direction where the majority hooks trailed at both drawing processes, led at roving and trailed into spinning, was less for the short staple cottons of this study than for a medium staple cotton of a previous study.

(43) SINGH, A. – FIBER HOOKS IN DRAWN COTTON SLIVER. Textile Res. Jour. 35: 87 – 88. 1965.

When fiber hooks are U-shaped they are much more difficult to remove during drafting. Of the hooked fibers of card sliver, 35 percent are U-shaped. Although the percentage of total hooked fibers decreased with each drafting operation, the proportion of U-shaped fibers increased.

(44) ARISTOV, P. I. – DETERMINING FIBER ORIENTATION IN THE SLIVER. Technol. Textile Indus. U.S.S.R. 5: 23 – 25. 1966.

The value of the coefficient of relative parallelization $(1 - \frac{C}{C+N+E})$ (100) and hooked fiber index $(\frac{E}{E+N})$ (100) were studied for determining fiber orientation. The hooked fiber index is essentially the cutting ratio (E/N) of the modified Lindsley test. Contradictions between the values of hook fiber index and the coefficient of relative parallelization often occurred. The hook fiber index was always found to correlate highly with yarn quality tests. The use of the hooked fiber index was advocated for determining fiber orientation in research labs and mills.

(45) BELIN, R. E., AND TAYLOR, D. S. – THE INFLUENCE OF HOOKED FIBERS ON COTTON COMBER WASTE. Textile Res. Jour. 36: 542 – 546. 1966.

Theoretical formulae were derived which give the number of fibers removed as comber noils caused by breaking fiber hooks. These formulae explain why that with a small gage setting more noils are removed when the fiber hooks are leading than trailing, and why at a wide gage setting the opposite is true.

(46) DZHOKHARIDZE, G. V. – THE STRAIGHTENING OF FIBER HOOKS ON THE CARD. Technol. Textile Indus. U.S.S.R. 4: 43 – 48. 1966.

Models of hooks in a drafting system were devised and mathematical expressions derived, depicting the unhooking of both leading and trailing hooks during drafting. These expressions showed that the leading hook cannot be completely straightened, especially with high drafts. However, the expressions showed that the trailing hook will be eliminated.

(47) SIMPSON, J., DELUCA, L. B., AND FIORI, L.A. – EFFECT OF FIBER HOOKS ON YARN PROPERTIES AND END BREAKAGE IN SPINNING FOR A COMBED AND CARDED EXTRA-LONG STAPLE COTTON. Textile Indus. 130(3): 90 – 94, 114. 1966.

An improvement in sliver uniformity and reduction in spinning end breakage were obtained for carded yarns when the majority hooks trailed into first and second drawing, led into roving, and trailed in the spinning operations. Fiber hook removal was the same whether hooks led at first drawing, trailed at second, or trailed at first and led at second. When the majority hooks trailed into the comber, more noils were removed and poorer fiber separation was obtained than when they led. For two lots where the majority hooks led into the comber, the one having slightly more majority hooks entering and slightly less minority hooks trailing than the other resulted in slightly more noils being removed and slightly better fiber spearation. Combing so effectively removed the fiber hooks that their effect on the postcombing operations and spinning end breakage was negligible.

(48) SIMPSON, J., DELUCA, L. B., AND FIORI, L.A.– EFFECT OF CARDING RATE AND CYLINDER SPEED ON FIBER HOOKS AND SPINNING PERFORMANCE. Textile Bul. 92, 4: 31 – 34, 36, 38. 1966

When carding rate was increased (constant sliver weight) for two medium staple Deltapine raingrown cottons, the minority hooks increased and the majority hooks decreased. The rate of increase in the minority hooks and the decrease in the majority hooks were different for the two cottons. The less mature cotton had a higher rate of increase in minority hooks with increase carding rate. When cylinder speed was increased, the majority hooks increased and the rate of increase in minority hooks with carding rate was lowered.

Increased carding rate slightly increased card sliver variation but improved the variation of first and second drawing sliver and decreased spinning end breakage. This was due to the decrease of majority hooks with increased carding rate which yielded a longer effective fiber length. This improved drafting uniformity and reduced spinning end breakage. The SURDD recommended drafting direction improved sliver uniformity and reduced end breakage over the conventional drafting direction at every carding rate.

(49) YAKOVLEV, V. V., LEONT'EVA, I. S., AND ZHOKHOVSKII, V. V. – COMPARISON OF METHODS OF DETERMINING FIBER PARALLELIZATION AND STRAIGHTNESS IN SLIVER AND ROVING. Technol. Textile Indus., U.S.S.R. 4: 20 – 23. 1966.

An optical method based on the uneven spatial distribution of light scattered by oriented fibers, a mechanical method based on measuring the elongation of sliver gripped within the fiber length, and the coefficient of relative parallelization and hooked fiber index (cutting ratio) of the modified Lindsley method were evaluated for determining fiber parallelization in sliver and roving. Each was found to have certain advantages.The advantage of the optical method was that it could measure parallelization while the machinery was running. The hooked fiber index gave the most information since it not only gave parallelization but also indicated the amount of fiber hooks in each direction of the sliver.

(50) KARASEV, G. I. – THE INFLUENCE OF THE CYLINDER SPEED OF FLAT CARDS ON THE TECHNOLOGICAL PROCESS OF CARDING. Technol. Textile Indus. U.S.S.R. 4: 58 – 66. 1967.

The effect of increasing the speed of the card on the residual fiber layer on the cylinder, sliver uniformity, and fiber orientation was investigated. A photoelectric technique was used for measuring the residual fiber layer on the cylinder and the modified Lindsley technique was used for measuring fiber orientation of the sliver. Increasing the carding speed reduces the residual fiber layer, sliver uniformity, and fiber parallelization and increases fiber hooking and carding action (wires/gram of fiber).

(51) OWALEKAR, R. G. – COMBING AND CUTTING RATIOS. Jour. Textile Inst. 58: 326 – 328. 1967.

With the assumption that the clamping plate width is longer than the maximum fiber length, theoretical formulae for the combing ratios in the forward and backward directions and the index of relative differential fiber-hooking were derived. The formula for the index of relative differential fiber-hooking is independent of the plate width. It is shown that the measure percent E in the forward direction is not independent of trailing hooks.

(52) SIMPSON, J., DELUCA, L. B., AND FIORI, L.A.– EFFECT OF CARDING RATE AND CYLINDER SPEED ON FIBER HOOKS AND SPINNING PERFORMANCE FOR AN IRRIGATED ACALA COTTON. Textile Res. Jour. 37: 504 – 510. 1967.

Increased carding rate increased minority and decreased majority hooks. The rate at which the minority hooks increased was greater for the Acala 4-42 cotton than a Deltapine cotton previously investigated. Generally, second-drawing sliver uniformity and end breakage were not affected by increased in carding rates. High carding rates resulted in less noils being removed at the comber without detrimentally affecting fiber length, yarn properites, or end breakage. Yarn imperfections and minority hooks of card sliver were related, indicating that the phenomena which produces minority hooks under these conditions also produces neps and thereby yarn imperfections. This study demonstrated that each type of cotton had its own peculiar fiber-hook formation pattern as carding rate was increased.

(53) YAKOVLEV, V. V. – ANALYSIS OF AN OPTICAL METHOD OF DETERMINING THE DEGREE OF FIBER PARALLELIZATION. Technol. Textile Indus. 1: 53 – 60. 1967.

Described is an optical method for measuring fiber parallelization, which is based on the measurement of the luminous flux scattered by the specimen when the light is directed in the vertical plane and in the plane parallel to the axis of the specimen. The measurement of parallelization varied with the thickness of the material (fiber per cross section) until a weight of 20 mg./cm.^{2} was obtained. The measurement also varied with the type of fiber, such as cotton, viscose, and lavsan.

(54) DELUCA, L. B., SIMPSON, J., AND FIORI, L.A.– AN EVALUATION OF FIBER PARALLELIZATION AND DRAFTING TENACITY OF COTTON SLIVER. Textile Res. Jour. 38: 817 – 823. 1968.

The effects of fiber parallelization and drafting tenacity were investigated on several cottons. The average drafting tenacity within each cotton was directly related to the total amount of hooks present before drafting. When one cotton was processed through eight drawings, the total amount of hooks and drafting tenacity, after each process, were logarithmetically related to the number of processes with a decrease in slope occurring for each property after the fourth drawing process. When the majority hooks trailed at first and second drawing, fiber parallelization increased over the conventional drafting direction. A linear relationship existed between hooks in roving and hooks in the sliver fed to the roving frame.

(55) FIORI, L. A., SIMPSON, J., AND DELUCA, L.B.– FIBER HOOKS – HOW THEY AFFECT PROCESSING PERFORMANCE. Textile World, 118(2): 58 – 62. 1968.

A summary of the effect of draft direction, carding rate, and fiber properties on fiber hooks and processing performance is given. For carded yarns the majority hooks should always trail into spinning and should be drafted in the trailing direction in as many

of the prespinning processes as possible. For combed yarns the majority hooks should always lead into the combing process and should be drafted in the trailing direction in as many of the precombing processes as possible. The combing and postcombing operations reduce hooks to such a low level that their direction in spinning is unimportant. For cottons of low or moderate nepping potential high production carding should result in a reduction in the majority hooks and resultant improvement in drawing sliver uniformity, reduction in ends down in spinning, and reduced comber noil percentage.

The major factors of fiber hook formation and elimination are mechanical variables rather than fiber properties. Five methods for drafting carded yarns and four methods for drafting combed yarns are described.

(56) GHOSH, G. C., AND BHADURI, S. N. – STUDIES ON HOOK FORMATION AND CYLINDER LOADING ON THE COTTON CARD. Textile Res. Jour. 38: 535 – 543. 1968.

The effect of various carding parameters on fiber hooking and loading characteristics and on yarn quality was investigated for a California 1-5/32 in. cotton, using the tracer fiber technique. Lickerin speeds and method of doffing the card web had no effect on the pattern of hook formation, which is influenced mainly by cylinder and doffer speeds and the hank of the delivered sliver When the cylinder to doffer speed ratio was increased either by increasing cylinder speed (constant sliver weight) or reducing doffer speed (increasing sliver weight), there was an increase in the majority hooks and decrease in the minority hooks. This was also true when sliver weight was increased at a constant cylinder to doffer speed ratio (production constant) and when sliver weight was increased by merely reducing the draft. No clear-cut relationship between loading and fiber hooking was found. Increased doffer and cylinder speeds, at constant carding rate, decreased yarn imperfections.

(57) NOZAKI,C.,HASEGAWA, J.,AND HIROSHI, N. – HOW THE QUALITY OF COTTON YARN PROCESSED BY A HIGH PRODUCTION CARD IS AFFECTED BY ITS CYLINDER, TAKER-IN AND DOFFER SPEEDS, SLIVER WEIGHT AND PRODUCTION RATE. Jour. Textile Mach. Soc. Japan, 14(5): 137 – 142. 1968.

Using a Toyoda CK-7C high production card, the effect of cylinder speed (250 to 600 rpm), taker-in speed (600 to 1500 rpm), doffer speed (15 to 33rpm), sliver weight (54 to 108 gr./yd.) and production rate (34 to 75 lbs./hr.) on cylinder load, coefficient of fiber transfer, fiber hooks, neps, sliver uniformity, trash, fiber length and yarn properties were investigated. Increasing the cylinder speed decreased the cylinder load, did not affect fiber transfer or majority hooks, increased the minority hooks, decreased fiber length, sliver uniformity and neps. Increasing sliver weight by reducing doffer speed (constant production), increased the cylinder load, decreased the fiber transfer, did not affect waste removal, majority hooks, or fiber length, increased neps and decreased sliver uniformity. Increasing production by sliver weight (doffer speed constant), increased the cylinder load and neps, did not affect fiber transfer or fiber length, decreased fiber hooks and sliver uniformity. Increasing production rate by doffer speed (constant sliver weight – 84.6 gr./yd.) increased cylinder load, fiber transfer, and neps but did not affect fiber hooks, length or sliver uniformity.

(58) PITTMAN, R. A., AND TALLANT, J. D. – MATHEMATICAL MODELS AND MEASUREMENT OF FIBER HOOKS. Textile Res. Jour. 38: 576 – 582. 1968.

A general equation for the variation of number and weight length distributions of the lengths of fibers as measured in projection along some fiber structure is described. Two models are examined and one model, "the ideal random hook" is used to derive expressions for the "equivalent random hooks per fiber." The probability of a fiber of a length y having an ideal hook so that its projected length is x to $x + \Delta x$ is given by $\frac{2\Delta x}{y}$. Experimental techniques for determining the parameters necessary to measure hooks by the method are discussed. Expressions for the excess number of hooks on one end of the fibers over the other end are derived and the experimental technique for their evaluation analyzed.

(59) SIMPSON, J. – OBSERVATIONS FOR IMPROVING COTTON CARDING. Textile Res. Jour. 38: 103 – 104. 1968.

Discussed are the use of Baturin's cylinder-to-doffer fiber transfer equations to determine the effect of tooth angle and density of doffer and cylinder, cylinder speed and doffer size on cylinder load and fiber hooks. The equations show that for optimum fiber transfer the tooth angle should be approximately 85° and 45° on cylinder and doffer, respectively. The tooth angle on cylinder and doffer has a more critical effect on cylinder load than either tooth density or size doffer. It is suggested that a possible way to improve fiber transfer is to reduce the coefficient of friction of the cylinder relative to the doffer.

(60) TALLANT, J. D., AND PITTMAN, R. A. – BREAKAGE MODELS AND MEASURING TECHNIQUES FOR FIBER WEIGHT-LENGTH DISTRIBUTIONS. Textile Res. Jour. 38: 149 – 155. 1968.

Previously developed number frequency equations are translated into their weight frequency counterparts. A solution is developed for the problem of fiber length distribution to be expected when a sliver or similar textile structure, with straight fibers, is cut systematically. When the cutting length is longer than the longest fiber the equation reduces to an expression which gives the mean length on a weight basis of the fiber distribution. In a normal textile sturcture, where the fibers are not straight and parallel, the expression is the "projected mean length". Simple methods for measuring the projected mean length are described and data presented showing the changes taking place from card sliver through roving. The basic mathematical equations for the Lindsley combing ratio are derived, and it is shown that a modification of the Lindsley technique can also yield the projected mean length.

(61) TALLANT, J. D., PITTMAN, R. A., AND PATUREAU, M. A. – SIMPLE FIBER LENGTH MEASUREMENT LEADS TO REDUCED END BREAKAGE. Textile Bull. 94(5): 30 – 35, 64. 1968.

Description of single and double clamp procedures for obtaining the projected mean length are given. The formulae for obtaining the "ideal random hook" are given.

An industrial plant using the single clamp procedure found that the projected mean length of roving in two of its mills was equal and less than that of second drawing sliver. After correcting roll settings in one mill and draft distribution in another, spinning end breakage decreased 20 to 25 percent.

(62) SIMPSON, J., AND FIORI, L. A. – THE IMPORTANCE OF FIBER HOOKS AND PARALLELIZATION TO PROCESSING EFFICIENCY AND YARN PROPERTIES. [In press] Proceedings of First International Cotton Research Symposium, Institut Textile de France, Paris, France. 1969.

Methods for measuring fiber hooks and parallelization in sliver and roving are presented. Also discussed is research on the effect that carding variables, drawing frame variables, sliver weight, drafting direction, and fiber properties have on fiber hook formation and reduction, fiber parallelization in sliver and resultant effects on processing performance.

Two measures of fiber parallelization are needed; one for overall fiber parallelization and one for fiber hooks. The projected mean length or the percent weight gripped can be employed as measures of fiber parallelization and the cutting ratio or similar index as a measure of fiber hooks.

The main fiber properties affecting fiber hooks are length and Micronaire reading.

With constant processing conditions the effect of the fiber properties, per se, on spinning performance overshadowed the effect of fiber hook differences induced by the fiber properties. However, with the same cotton, changes in processing conditions had significant effects on fiber parallelization and hooks, which in turn significantly affected noil removal and spinning end breakage.

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